2 DESCRIPTION AND COMPARISON OF ALTERNATIVES

Alternatives for building and operating a DUF_6 conversion facility at the Paducah site were evaluated for their potential impacts on the human and natural environment. This EIS considers the proposed action of building and operating a conversion facility and a no action alternative. Under the proposed action, three action alternatives are considered that focus on where to construct the conversion facility within the Paducah site. An option of shipping cylinders currently stored at ETTP to the Paducah facility is also considered. The no action alternative assumes that a conversion facility is not built at Paducah and that the DUF_6 cylinders at Paducah would continue to be stored indefinitely in a manner consistent with current management practices. This chapter defines these alternatives and options in detail and discusses the types of activities that would be required under each. A summary of the alternatives considered in this EIS is presented in Table 2.1-1.

Alternatives Considered in This EIS

No Action — NEPA regulations require evaluation of a no action alternative. In this EIS, the no action alternative is storage of DUF_6 cylinders indefinitely in yards at the Paducah site, with continued cylinder surveillance and maintenance activities.

Proposed Action — Construction and operation of a DUF_6 conversion plant at the Paducah site. DUF_6 would be converted to depleted U_3O_8 based on the UDS conversion technology.

Action Alternatives — Three action alternatives focus on where to construct the conversion facility within the Paducah site (Alternative Locations A, B, and C). The preferred alternative is Location A.

A separate EIS prepared for construction and operation of a conversion facility at the Portsmouth site (DOE 2003a) also includes a no action alternative. The no action alternative defined in the Portsmouth EIS includes an evaluation of the potential impacts of indefinite long-term storage of cylinders at the Portsmouth site as well as the continued long-term storage of cylinders at the ETTP site.

In addition to describing the alternatives evaluated in this EIS, this chapter includes a discussion of alternatives considered but not analyzed in detail (Section 2.3) and a summary comparison of the potential environmental impacts from the alternatives (Section 2.4). The comparison of alternatives is based on information about the environmental setting provided in Chapter 3, descriptions of the assessment methodologies provided in Chapter 4, and the detailed assessment results presented in Chapter 5.

No Action Alternative

It is assumed that the DUF_6 cylinders would continue to be stored indefinitely at the Paducah site and that cylinder surveillance and maintenance would also continue. Impacts are evaluated through the year 2039; in addition, potential long-term (after 2039) impacts are evaluated.

2.1 NO ACTION ALTERNATIVE

Under the no action alternative, it is assumed that DUF_6 cylinder storage would

TABLE 2.1-1 Summary of Alternatives Considered

Alternative	Description	Options Considered
No Action (Section 2.1)	Continued storage of the DUF_6 cylinders indefinitely at the Paducah site, with continued cylinder surveillance and maintenance.	None.
Proposed Action (Section 2.2)	Construction and operation of a DUF_6 conversion facility at the Paducah site. This EIS assesses the potential environmental impacts from the following proposed activities: • Construction, operation, maintenance, and D&D of the proposed DUF_6 conversion facility at the Paducah site; • Conversion to depleted U_3O_8 based on the proposed UDS technology; • Transportation of uranium conversion products and waste materials to a disposal facility; • Transportation and sale of the HF conversion product; and • Neutralization of HF to CaF_2 and its sale or disposal in the event that the HF product is not sold.	*ETTP Cylinders:* This EIS considers an option of shipping DUF_6 and non-DUF_6 cylinders at ETTP to Paducah. Two options are considered for preparing noncompliant ETTP cylinders for transportation: cylinder overpacks and the use of a transfer facility to transfer the cylinder contents to compliant cylinders. *Transportation:* This EIS evaluates the shipment of cylinders and conversion products by both truck and rail.
Alternative Location A (Preferred) (Section 2.2.1.1)	Construction of the conversion facility at Location A, an area that encompasses 35 acres (14 ha) located south of the administration building and its parking lot, immediately west of and next to the primary location of the DOE cylinder yards and east of the main plant access road.	
Alternative Location B (Section 2.2.1.2)	Construction of the conversion facility at Location B, an area that encompasses 59 acres (23 ha) directly south of the Paducah maintenance building and west of the main plant access road.	
Alternative Location C (Section 2.2.1.3)	Construction of the conversion facility at Location C, an area that encompasses 53 acres (21 ha) east of the Paducah pump house and cooling towers.	

continue indefinitely at the Paducah site. The no action alternative assumes that DOE would continue surveillance and maintenance activities to ensure the continued safe storage of cylinders. Potential environmental impacts are estimated through the year 2039. The year 2039 was selected to be consistent with the DUF_6 PEIS (DOE 1999a), which evaluated a 40-year storage period (1999 through 2039). In addition, long-term impacts (i.e., occurring after 2039) from potential cylinder breaches are assessed. A similarly defined no action alternative was also evaluated in the DUF_6 PEIS. The assessment of the no action alternative in this EIS has been updated to reflect changes that have occurred since publication of the DUF_6 PEIS in 1999. Details are provided below.

Specifically, the activities assumed to occur include routine cylinder inspections, ultrasonic testing of the wall thicknesses of selected cylinders, painting of cylinders to prevent corrosion, cylinder yard surveillance and maintenance, reconstruction of several storage yards, and relocation of some cylinders to the new or improved yards. It is assumed that cylinders would be painted every 10 years. On the basis of these activities, an assessment of the potential impacts on workers, members of the public, and the environment was conducted.

Breached cylinders are cylinders that have a hole of any size at some location on the wall. The occurrence of cylinder breaches, caused by either corrosion or handling damage, is an important concern when the potential impacts of continued cylinder storage are evaluated. There is a general concern that the number of cylinder breaches at the site could increase in the future as the cylinder inventory ages.

At the time the PEIS was published (1999), 8 breached cylinders had been identified at the three storage sites; 1 of those breaches was at the Paducah site.[1] Investigation of these breaches indicated that 6 of the 8 were initiated by mechanical damage during stacking; the damage was not noticed immediately, and subsequent corrosion occurred at the damaged point. It was concluded that the other 2 cylinder breaches, both at ETTP, had been caused by external corrosion due to prolonged ground contact.

For assessment purposes in this EIS, two cylinder breach cases are evaluated. In the first case, it is assumed that the planned cylinder maintenance and painting program would maintain the cylinders in a protected condition and control further corrosion. In this case, it is assumed that after initial painting, some cylinder breaches would occur from handling damage; a total of 36 future breaches are estimated to occur through 2039. In the second case, it is assumed that external corrosion would not be halted by improved storage conditions, cylinder maintenance, and painting. This case is considered in order to account for uncertainties with regard to how effective painting would be in controlling cylinder corrosion and uncertainties in the future painting schedule. In this case, the number of future breaches estimated through 2039 is 444 for the Paducah site (i.e., 11 per year). These breach estimates were determined on the basis of historical corrosion rates when cylinders were stored under poor conditions (i.e., cylinders were stacked too close together, were stacked on wooden chocks, or came in contact with the ground). Because storage conditions have improved dramatically over the last several years as a result of

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[1] In the period 1998 through 2002, two additional breaches were discovered at the Paducah site, the result of missing cylinder plugs (Hightower 2002).

cylinder yard upgrades and restacking activities, it is expected that these breach estimates based on the historical corrosion rate provide a worst case for estimating the potential impacts from continued cylinder storage. The results of this assessment were used to provide an estimate of the earliest time when continued cylinder storage could begin to raise regulatory concerns under these worst-case conditions.

The impacts to human health and safety, surface water, groundwater, soil, air quality, and ecology from uranium and HF releases from breached cylinders are assessed in this EIS. For all hypothetical cylinder breaches, it is assumed that the breach would be undetected for 4 years, which is the period between planned inspections for most of the cylinders. In practice, cylinders that show evidence of damage or heavy external corrosion are inspected annually, so it is very unlikely that a breach would be undetected for a 4-year period. For each hypothetical cylinder breach, it is further assumed that 1 lb (0.45 kg) of uranium (as UO_2F_2) and 4.4 lb (2 kg) of HF would be released from the cylinder annually for a period of 4 years.

The estimated number of future breaches at the Paducah site was used to estimate potential impacts that might occur during the repair of breached cylinders and impacts from releases that might occur during continued cylinder storage. Potential radiological exposures of involved workers could result from patching breached cylinders or emptying the cylinder contents into new cylinders. The impacts on groundwater and human health and safety from uranium releases were assessed by estimating the amount of uranium that could be transported from the yards in surface runoff and the amount that could migrate through the soil to the groundwater.

For this EIS, a reassessment of the no action alternative assumptions used in the PEIS was conducted. Recent cylinder surveillance and maintenance plans — including inspections, painting, and reconstruction of cylinder storage areas — were used to update the PEIS no action alternative assessments. The results of this reevaluation, together with a consideration of the changes in the on-site worker and off-site public populations at Paducah, were used to determine the impacts from the no action alternative. Additional discussion and the estimated impacts from the no action alternative are presented in Section 5.1.

2.2 PROPOSED ACTION

The proposed action evaluated in this EIS is to construct and operate a conversion facility at the Paducah site for converting the DUF_6 inventory stored at Paducah. Three locations within the Paducah site are evaluated as alternatives (Section 2.2.1). The conversion facility would convert DUF_6 into a stable chemical form for beneficial use/reuse and/or disposal. The off-gas from the conversion process would yield aqueous HF, which would be processed and marketed or converted to a solid for sale or disposal. To support the conversion operations, the emptied DUF_6 cylinders would be

> **Proposed Action**
>
> The proposed action in this EIS is construction and operation of a DUF_6 conversion facility at the Paducah site. DUF_6 would be converted to depleted U_3O_8. Three alternative locations within the Paducah site are evaluated (Locations A, B, and C).

stored, handled, and processed for disposal. The time period considered is a construction period of approximately 2 years, an operational period of 25 years, and a 3-year period for the D&D of the facility. Current plans call for construction to begin in the summer of 2004. The assessment is based on the conceptual conversion facility design proposed by UDS, the selected contractor (see text box).

Conversion Facility Design

The EIS is based on the conversion facility design being developed by UDS, the selected conversion contractor. At the time this draft EIS was prepared, the UDS design was in the conceptual stage, with several facility design options being considered. This EIS identifies and evaluates these options to the extent possible.

Following the public comment period, the draft EIS will be revised on the basis of comments received and in order to incorporate any significant changes that occurred in the conversion facility design.

This EIS assesses the potential environmental impacts from the following proposed activities:

- Construction, operation, maintenance, and D&D of the proposed DUF_6 conversion facility at the Paducah site;
- Transportation of uranium conversion products and waste materials to a disposal facility;
- Transportation and sale of the HF conversion product; and
- Neutralization of HF to CaF_2 and its sale or disposal in the event that the HF product is not sold.

In addition, issues related to extended conversion facility operations are discussed in this section.

2.2.1 Action Alternatives

The action alternatives focus on where to site the conversion facility within the Paducah site. The Paducah site was evaluated to identify alternative facility locations for a conversion facility (Shaw 2001). Potential locations were evaluated on the basis of the following criteria:

- *Current condition of the land and site preparation required*. This criterion looked at the condition of the land from a constructability viewpoint, considering factors that would increase the construction cost over that needed for a relatively level grassy topography.
- *Legacy environmental concerns*. This criterion looked at environmental factors that would affect construction at the site.

- *Availability of utilities.* This criterion looked at the relative difficulty of bringing services from existing plant utilities to the site.
- *Location*. This criterion looked at the advantages and disadvantages of location in relation to cylinder transport between the yards and the new facility.
- *Effect on current plant operations*. This criterion looked at how the conversion facility's location could affect existing plant operations.
- *Size*. This criterion looked at size to ensure that the required minimum amount of land would be available for construction of the conversion facility (assumed to be about 30 acres [12 ha]).

The three alternative locations identified at the Paducah site, denoted Locations A, B, and C, are shown in Figure 2.2-1.

2.2.1.1 Alternative Location A (Preferred Alternative)

Location A is the preferred location for the conversion facility. It is located south of the administration building and its parking lot, immediately west of and next to the primary location of the DOE cylinder yards and east of the main plant access road. This location is an L-shaped tract consisting mostly of grassy field. However, the southeastern section is a wooded area. A drainage ditch crosses the northern part of the site, giving the cylinder yard storm water access to Kentucky Pollution Discharge Elimination System (KPDES) Outfall 017. This location is about 35 acres (14 ha) in size and was identified in the RFP for conversion services as the site for which bidders were to design their proposed facilities.

2.2.1.2 Alternative Location B

Location B is directly south of the Paducah maintenance building and west of the main plant access road. The northern part of this location is mowed grass and has a slightly rolling topography. The southern part has a dense covering of trees and brush, and some high-voltage power lines cross it, which limits its use. This location has an area of about 59 acres (23 ha).

2.2.1.3 Alternative Location C

Location C is east of the Paducah pump house and cooling towers. It has an area of about 53 acres (21 ha). Dykes Road runs through the center of this location from north to south. Use of the eastern half of this location could be somewhat limited because several high-voltage power lines run through this area.

2.2.2 Conversion Process Description

This section provides a summary description of the proposed UDS conversion process and facility. The proposed UDS conversion system is based on a proven commercial process in operation at the Framatome Advanced Nuclear Power (ANP), Inc., fuel fabrication facility in Richland, Washington. The two primary sources for the information in this section are excerpts from the UDS conversion facility 30% conceptual design report (UDS 2003a) and the UDS NEPA data package (UDS 2003b).

The UDS dry conversion is a continuous process in which DUF_6 is vaporized and converted to uranium oxide (U_3O_8) by reaction with steam and hydrogen in a fluidized-bed conversion unit. The resulting depleted U_3O_8 powder is collected and packaged for disposition. The process equipment would be arranged in parallel lines. Each line would consist of two autoclaves, two conversion units, an HF recovery system, and process off-gas scrubbers. The Paducah facility would have four parallel conversion lines. Equipment would also be installed to collect the HF co-product and process it into any combination of several marketable products. A backup HF acid neutralization system would be provided to convert up to 100% of the HF acid to CaF_2 for storage and/or sale in the future, if necessary. Figure 2.2-2 is an overall material flow diagram for the conversion facility; Figure 2.2-3 is a conceptual facility site plan. A summary of key facility characteristics is presented in Table 2.2-1.

The conversion facility will be designed to convert 18,000 t (20,000 tons) of DUF_6 per year, requiring 25 years to convert the Paducah inventory. The Paducah processing facility would be approximately 251 ft × 110 ft (77 m × 34 m). The total footprint of the Paducah processing facility would be approximately 22,920 ft^2 (2,129 m^2). The conversion facility would occupy a total of approximately 10 acres (4 ha), with up to 45 acres (18 ha) of land disturbed during construction (including temporary construction lay-down areas and utility access). Some of the disturbed areas would be areas cleared for railroad or utility access, not adjacent to the construction area.

DUF_6 cylinders would be delivered from long-term storage to the cylinder staging yard at the conversion facility by means of cylinder handling equipment already available at the site. The staging yard would accommodate short-term storage of cylinders. Cylinders in the conversion staging yard would be transferred into the conversion building airlock by using an overhead bridge crane. The cylinders would then be moved into the vaporization room to the autoclaves by an overhead monorail crane and/or rail cart. The cylinders would be loaded into autoclaves for heating and transfer of the DUF_6 to the conversion units.

Cylinders that could not be processed through the normal process feed system would be processed through the cylinder transfer facility. If the cylinder was overfilled, the excess DUF_6 would be transferred to another cylinder. This same system would be used to transfer all of the contents from unacceptable cylinders to cylinders suitable for feeding into the conversion process.

After the emptied cylinder was removed from the autoclave, a stabilizing agent would be introduced into the cylinder to neutralize residual fluoride in the heel. The cylinders would then

TABLE 2.2-1 Summary of Paducah Conversion Facility Parameters

Parameter/Characteristic	Value
Construction start	2004
Construction period	2 years
Start of operations	2006
Operational period	25 years
Facility footprint	10 acres (4 ha)
Facility throughput	18,000 t/yr (20,000 tons/yr) DUF_6 (≈1,400 cylinders/yr)
Conversion products	
Depleted U_3O_8	14,300 t/yr (15,800 tons/yr)
CaF_2	24 t/yr (26 tons/yr)
70% HF acid	3,300 t/yr (3,600 tons/yr)
49% HF acid	7,700 t/yr (8,500 tons/yr)
Steel (emptied cylinders, if not used as disposal containers)	1,980 t/yr (2,200 tons/yr)
Proposed conversion product disposition (see Table 2.2-2 for details)	
Depleted U_3O_8	Disposal; Envirocare (primary), NTS (secondary)
CaF_2	Disposal; Envirocare (primary), NTS (secondary)
70% HF acid	Sale pending DOE approval
49% HF acid	Sale pending DOE approval
Steel (emptied cylinders, if not used as disposal containers)	Disposal; Envirocare (primary), NTS (secondary)

Sources: UDS (2003a,b).

be moved out to the staging yard for a minimum 4-month aging period so that short-lived uranium decay products in the nonvolatile heel would decay, thereby reducing potential radiation exposure during the processing of emptied cylinders. Emptied cylinders would then be processed and disposed of as LLW or reused as disposal containers.

Major conversion system components are described further in the following subsections. The plant design includes several other supporting facilities and services, including an electrical system with backup, a communications system, a deionized water system, a control system, an air supply system, a fire protection system, and a heating, ventilation, and air-conditioning system.

2.2.2.1 Cylinder Transfer System

Some cylinders might be unacceptable for processing in the vaporization system autoclaves because of corrosion, damage, overfilling, or excessive size. A cylinder transfer system would be used to transfer the contents of up to four unacceptable cylinders per week to acceptable cylinders. Cylinder transfer system equipment would include two low-temperature autoclaves, four fill positions, a "hot box" containing controls and vacuum pumps, and an oversize cylinder heating room. Fill positions would include a water spray cooling system necessary for low-temperature DUF_6 transfer. The oversize cylinder heating room would contain radiant heating enclosure controls and connections.

2.2.2.2 Vaporization System

Cylinders that met the vaporization criteria would be brought to the vaporization room and loaded into electrically heated autoclaves. Autoclaves for each process line would be used to provide continuous feed to the DUF_6 conversion units. The cylinders would be heated to feed DUF_6 vapor to the process. The design will incorporate in-line filters to provide additional assurances that TRU isotopes would not enter the conversion system. The need for in-line filters would be evaluated during operations; they would be removed if they were not needed.

The DUF_6 vapor would flow through a heated enclosure called a "hot box," which would contain the equipment that would control flow to the conversion units, including vacuum pumps. The hot box would have the necessary controls to achieve stable DUF_6 flow to the conversion units.

The autoclaves would be used to heat DUF_6 cylinder by using internal electrical heating and to provide secondary DUF_6 containment. The selected autoclaves would be American Society of Mechanical Engineers standard pressure vessels, sufficiently designed to provide containment of DUF_6 and HF from a full, DUF_6 cylinder that had ruptured. Each autoclave system would include equipment and controls to connect to the cylinder, control DUF_6 flow, monitor DUF_6 weight, and control vaporization conditions.

Electrically heated autoclaves would provide a safety advantage over steam-heated units. If DUF_6 leaks in a steam autoclave, it reacts with the steam and generates HF gas, which pressurizes the autoclave and is extremely corrosive. If DUF_6 leaks in an electrically heated autoclave, however, the only moisture available is the humidity in the air, which limits HF generation and subsequent pressurization and corrosion. This also makes cleanup of the autoclave much easier since the autoclave is evacuated directly to the conversion unit and does not produce wet uranium recycle and liquid wastes.

2.2.2.3 Conversion System

DUF_6 vapor would be reacted with steam and hydrogen in fluidized-bed conversion units. The hydrogen would be generated by using anhydrous ammonia (NH_3). Nitrogen is also used as an inert purging gas and is released to the atmosphere through the building stack as part of the clean off-gas stream. The oxide powder would be retained in the conversion unit by passing the process off-gas through sintered metal filters. Uranium oxide powder would be continuously withdrawn from the conversion unit to match the feed rate of DUF_6. Each conversion unit would be electrically heated and integrated with a heating/insulation jacket.

All equipment components (vessels, filters, etc.) in the conversion system would be fabricated of corrosion-resistant alloys suited to process conditions. In the event of a system failure or an unscheduled shutdown, the DUF_6 shutoff valve in the autoclave would automatically close. The DUF_6 piping would then be purged with nitrogen. In the event of power, instrument, air, or other failure, a fail-safe design would be used for valves and for the control system.

2.2.2.4 Depleted Uranium Conversion Product Handling System

Depleted U_3O_8 powder would be cooled as it was discharged from the conversion unit. An in-line water-cooled heat exchanger would cool the powder before it dropped into a vacuum transfer station enclosure. The vacuum transfer station would include connections, a vacuum transfer pickup device, a support vessel, a hopper, and a secondary enclosure to facilitate bagging the depleted U_3O_8. A bulk bag fill station would be located below each hopper. Powder fill would be controlled by weight in the fill container, and a secondary containment enclosure would be provided at the fill station. The filled bags would be lifted and conveyed by using an overhead monorail crane through an airlock and loaded into gondola railcars for shipment to the disposal site. Each packaging station would operate on a semicontinuous basis with intermittent bag removal and installation. Continuous level control would maintain the oxide hopper at 20% to 25% of capacity. Prior to bag change out (twice per day), the oxide discharge would be stopped.

An option of using the emptied cylinders rather than bulk bags as disposal containers is also being considered. After being processed (see Section 2.2.2.6), the emptied cylinders would be moved to the conversion product transfer station and refilled with depleted U_3O_8 powder. The refilled cylinders would be sealed and loaded to railcars for shipment to the disposal site.

2.2.2.5 HF Recovery System

The fluorine component of the DUF_6 would leave the conversion unit as HF gas through sintered metal filters that would retain nearly all (greater than 99.9%) of the uranium in the conversion unit. The HF would be condensed, along with the unreacted excess steam, and the resulting HF acid would flow by gravity to receiver tanks. In addition, the off-gas would be passed through a series of two scrubbers to recover most of the uncondensed HF. In each scrubber, process off-gas would come into contact with 20% potassium hydroxide (KOH) solution. HF vapor would combine with KOH in the solution to form potassium fluoride (KF) and water (H_2O); thus HF would be removed from the process off-gas stream.

The HF acid would be automatically transferred from the receivers to interim bulk storage tanks located outside the building. An in-line uranium analyzer in each transfer line would be used as a final verification that containment of the uranium is intact. High-integrity piping and equipment made with corrosion-resistant materials would result in zero leakage of HF, either gaseous or liquid, to the environment.

2.2.2.6 Emptied Cylinder Processing

If bulk bags were used for depleted U_3O_8 disposal containers, after a 4-month aging period, emptied cylinders (with heel) would be transported into the cylinder disposition facility. A forklift would be used to move the cylinders to the feed queue outside the facility airlock. Cylinders would then be brought into the disposition facility via an overhead monorail crane and placed into a compactor feed station. The plugs would be removed from the cylinder to vent the cylinder during crushing. The cylinder would then be pushed by a ram into the compactor itself, where it would be compacted radially to a maximum thickness of 8 in. (20 cm). The compacted cylinder would then be pushed to the cutting station, where it would be cut in half to reduce the length. The two pieces of metal would be picked up with an overhead crane and placed into an intermodal shipping container. Debris from these operations would then be collected in a container by a vacuum system and loaded into the intermodal container.

Secondary containment would be provided for the intermodal container loadout. In addition, small cylinders that had not been compacted, as well as valves, plugs, and facility secondary waste, might also be loaded into the intermodal containers. Cylinders that were destined for disposal at NTS would not be introduced into the facility but would instead be loaded directly onto trucks or railcars for transport.

UDS is considering an option of using the emptied cylinders as disposal containers. After aging, the cylinders would be modified to allow for refilling with depleted U_3O_8 powder. After modification, the cylinders would be moved to the conversion product transfer station and refilled. The refilled cylinders would be sealed and loaded to railcars for shipment to the disposal site. The cylinder refill option would minimize the need to dispose of emptied cylinders as a separate waste stream.

2.2.2.7 Management of Potential Transuranic Contamination

As discussed in Section 1.2.2, as a result of enrichment of reprocessed uranium in the early years of gaseous diffusion, some of the DUF_6 inventory is contaminated with small amounts of Tc and the TRU elements Pu, Np, and Am. TRU contamination in the cylinders would exist as fluoride compounds that would be both insoluble in liquid DUF_6 and nonvolatile but capable of being entrained from the cylinders during the vaporization and feeding of DUF_6 into the conversion process. The TRU contamination would exist primarily as (1) small particulates dispersed throughout the DUF_6 contents and (2) small quantities in the residual heels from the original feed cylinders in a relatively small but unknown number of cylinders (see Appendix B for more details). Tc contamination would exist as fluoride and oxyfluoride compounds that would be stable and partially volatile, and the contamination would be present both uniformly dispersed throughout the DUF_6 and in the heel material referred to previously.

The TRU contaminants that are dispersed throughout the DUF_6 might be entrained in the gaseous DUF_6 during the cylinder emptying operations and carried out of the cylinders. These contaminants could be captured in filters between the cylinders and the conversion units. These filters would be monitored and changed out periodically to prevent buildup of TRU. They would be disposed of as LLW.

It is also expected that the nonvolatile forms of Tc that exist in the cylinders would remain in the heels or be captured in the filters. However, because of the existence of some volatile technetium fluoride compounds, and for the purposes of analyses in this EIS, it is assumed that all of the Tc dispersed in the DUF_6 would volatilize with DUF_6 and be carried into the conversion process equipment. Any Tc compounds transferred into the conversion units would be oxidized along with the DUF_6. For this EIS, it is also assumed that the Tc in the form of oxides would partition into the U_3O_8 and HF products in the same ratio as the uranium. It is assumed that Tc left in the heels from the original feedstock would remain behind after the DUF_6 was vaporized.

If bulk bags were used for depleted U_3O_8 disposal, the emptied cylinders would be processed as described in Section 2.2.2.6. The emptied cylinders would be surveyed by using nondestructive assay techniques to determine the presence of a significant quantity of TRU isotopes. If TRU isotopes were detected, samples would be taken and analyzed. Cylinders that exceeded the disposal site limits at the Envirocare of Utah, Inc., facility would be treated to immobilize the heel (e.g., with grout) within the cylinder, compacted, and sectioned; then the cylinder/heel waste stream would be sent to NTS and disposed of as LLW.

2.2.3 Conversion Product Disposition

The conversion process would generate four conversion products that have a potential use or reuse: depleted U_3O_8, HF, CaF_2, and steel from emptied DUF_6 cylinders (if not used as disposal containers). DOE has been working with industrial and academic researchers for several years to identify potential uses for these products. Some potential uses for depleted uranium exist or are being developed, and DOE believes that a viable market exists for the HF generated during conversion. To take advantage of these to the extent possible, DOE requested in the RFP that the bidders for conversion services investigate and propose viable uses. The probable disposition paths identified by UDS for each of the conversion products are summarized in Table 2.2-2 (UDS 2003b).

According to UDS, of the four conversion products, only HF has a viable commercial market currently interested in the product. Therefore, UDS expects that the HF would be sold to a commercial vendor pending DOE approval of the residual contamination limits and the sale. Commercial-grade HF produced at the Framatome ANP, Inc. (a UDS partner), facility in Richland, Washington, is currently sold commercially under an NRC-approved license. UDS is currently working with DOE through a formal process to evaluate and establish authorized release limits for the HF. Details on this process and on HF sale and use are provided in Appendix E. Should the release of the HF not be allowed, it would be neutralized to CaF_2 for sale or disposal, creating about 2 t (2.2 tons) per 1 t (1.1 ton) of HF. UDS will seek to obtain DOE approval to sell this material as well. However, the market is not as strong as that for the HF; thus, the CaF_2 produced during normal operations might become waste.

Although the depleted U_3O_8 and emptied cylinders have the potential for use or reuse, currently none of the uses have been shown to be viable because of cost, perception, feasibility, or the need for additional study. Thus, UDS expects most, if not all, of the uranium oxide and emptied cylinders to become waste. These materials would be processed and shipped to Envirocare for disposal, as summarized in Table 2.2-2.

The EIS evaluation of conversion product disposition considers:

- Transportation of the uranium oxide conversion product and emptied cylinders by truck and rail to both Envirocare and NTS for disposal,

TABLE 2.2-2 Summary of Proposed Conversion Product Treatment and Disposition

Conversion Product	Treatment	Proposed Disposition	Optional Disposition
Depleted U_3O_8	U_3O_8 would be loaded into bulk bags (lift liners, 25,000-lb [11,000-kg] capacity) and loaded into gondola railcars (8 to 9 bags per car, depending on the car selected). An option of using the emptied cylinders as disposal containers is also being considered.	Disposal at Envirocare of Utah, Inc.[a]	Disposal at NTS.[a]
CaF_2	Similar to depleted U_3O_8.	Commercial sale pending DOE approval of authorized release limits.	Disposal at Envirocare of Utah, Inc.[a]
70% HF acid	HF produced by the dry conversion facility would be commercial grade. HF would be stored on site until loaded into rail tank cars.	Sale to commercial HF acid supplier pending DOE approval of authorized release limits.	Neutralization of HF to CaF_2 for use or disposal.
49% HF acid	HF produced by the dry conversion facility would be commercial grade. HF would be stored on site until loaded into rail tank cars.	Sale to commercial HF acid supplier pending DOE approval of authorized release limits.	Neutralization of HF to CaF_2 for use or disposal.
Steel (empty cylinders)	Emptied cylinders would have a stabilizing agent added to neutralize residual fluorine, be stored for 4 months, crushed to reduce the size, sectioned, and packaged in intermodal containers. An option of using the emptied cylinders as disposal containers is also being considered.	Disposal at Envirocare of Utah, Inc.[a]	Disposal at NTS.[a]

[a] In the event that other disposal options become available in the future, additional NEPA or environmental review may be required.

- Transportation and sale of the HF conversion product, and
- Neutralization of HF to CaF_2 and its sale or disposal in the event that the HF product is not sold.

For disposal of depleted uranium conversion products, transportation impacts are calculated for shipment to both NTS and Envirocare and by both truck and rail. Because specific destinations are unknown at this time, impacts from the shipment of HF and CaF_2 for use are based on a range of representative route distances. Additional details concerning the transportation assessment are provided in Appendix F, Section F.3.

2.2.4 Option of Shipping ETTP Cylinders to Paducah

DOE proposes to ship the DUF_6 and non-DUF_6 cylinders at ETTP to Portsmouth. However, this EIS considers an option of sending the ETTP cylinders to Paducah. If the ETTP DUF_6 cylinders were converted at Paducah, the Paducah facility would have to operate an additional 3 years, resulting in a total operational period of 28 years. For this option, this EIS evaluates the preparation of DUF_6 and non-DUF_6 cylinders at ETTP and the transportation of those cylinders to Paducah by several different methods, as described below.

All shipments of ETTP cylinders would have to be made in accordance with applicable DOT regulations for the shipment of radioactive materials as specified in Title 49 of the CFR (see text box and Chapter 6). The cylinders could be shipped by truck or rail.

The majority of DUF_6 cylinders were designed, built, tested, and certified to meet the DOT requirements. The DOT requirements are intended to maintain the safety of shipments during both routine and accident conditions. A summary of the applicable transportation regulations for shipment of UF_6 is provided in Chapter 6 of this EIS; a detailed discussion of pertinent transportation regulations is presented

Transportation Requirements for DUF_6 Cylinders

All shipments of UF_6 cylinders have to be made in accordance with applicable DOT regulations for the shipment of radioactive materials; specifically, the provisions of 49 CFR Part 173, Subpart I. The DOT regulations require that each UF_6 cylinder be designed, fabricated, inspected, tested, and marked in accordance with the various engineering standards that were in effect at the time the cylinder was manufactured. The DOT requirements are intended to maintain the safety of shipments during both routine and accident conditions. Three provisions are particularly important relative to DUF_6 cylinder shipments:

1. A cylinder must be filled to less than 62% of the certified volumetric capacity (the fill limit was reduced from 64% to 62% in about 1987).
2. The pressure within a cylinder must be less than 14.8 psia (subatmospheric pressure).
3. A cylinder must be free of cracks, excessive distortion, bent or broken valves or plugs, and broken or torn stiffening rings or skirts, and it must not have a shell thickness that has decreased below a specified minimum value. (Shell thicknesses are assessed visually by a code vessel inspector, and ultrasonic testing may be specified at the discretion of the inspector to verify wall thickness, when and in areas the inspector deems necessary.)

in Biwer et al. (2001). Cylinders meeting the DOT requirements could be loaded directly onto specially designed truck trailers or railcars for shipment. However, after several decades in storage, some cylinders have physically deteriorated such that they no longer meet the DOT requirements, or required cylinder documentation has been lost.

It is unknown exactly how many DUF_6 cylinders do not meet DOT transportation requirements. Problems are related to the following DOT requirements that must be satisfied before shipment: (1) documentation must be available showing that each cylinder was properly designed, fabricated, inspected, and tested prior to being filled; (2) cylinders must be filled to less than 62% of the maximum capacity; (3) the pressure within cylinders must be less than atmospheric pressure; (4) cylinders must not leak or be damaged so they are unsafe; and (5) cylinders must have a specified minimum wall thickness. Cylinders not meeting these requirements are referred to as "noncompliant." Some cylinders might fail to meet more than one requirement.

Three options exist for shipping noncompliant cylinders (Biwer et al. 2001):

1. The DUF_6 contents could be transferred from noncompliant cylinders into new or compliant cylinders.

2. An exemption could be obtained from DOT that would allow the DUF_6 cylinder to be transported either "as is" or following repairs. The primary finding that DOT would have to make to justify granting an exemption is this: the proposed alternative would have to achieve a safety level that would be at least equal to the level required by the otherwise applicable regulation or, if the otherwise applicable regulation did not establish a required safety level, would be consistent with the public interest and adequately protect against the risks to life and property that are inherent when transporting hazardous materials in commerce.

3. Noncompliant cylinders could be shipped in a protective overpack. In this case, the shipper would have to obtain an exemption from DOT that would allow the existing cylinder, regardless of its condition, to be transported if it was placed in a metal overpack. The metal overpack would have to be specially designed. Furthermore, DOT would have to determine that, if the overpack was fabricated, inspected, and marked according to its design, the resulting packaging (including the cylinder and the overpack) would have a safety level at least equal to the level required for a new UF_6 cylinder.

Before shipment, each cylinder would be inspected to determine if it met DOT requirements. This inspection would include a record review to determine if the cylinder was overfilled; a visual inspection for damage or defects; a pressure check to determine if the cylinder was overpressurized; and an ultrasonic wall thickness measurement (based on a visual inspection, if necessary). If a cylinder passed the inspection, the appropriate documentation would be prepared, and the cylinder would be loaded directly for shipment. The preparation of compliant cylinders (cylinders that meet DOT requirements) would include inspection activities, unstacking, on-site transfer, and loading onto a truck trailer or railcar. The cylinders would be secured by using the appropriate tiedowns, and the shipment would be labeled in accordance with DOT requirements. Handling and support equipment and the procedures for on-site movement and for loading the cylinders would be of the same type currently used for cylinder management activities at the storage sites.

This EIS considers two ways of preparing noncompliant cylinders at ETTP for shipment: cylinder overpacks and cylinder transfer. The information on these activities is based on preconceptual design data provided in the Engineering Analysis Report (Dubrin et al. 1997) prepared for the PEIS and the analysis of potential environmental impacts presented in Appendix E of the DUF_6 PEIS (DOE 1999a).

An overpack is a container into which a cylinder is placed for shipment. The metal overpack would be designed, tested, and certified to meet all DOT shipping requirements. It would be suitable for containing, transporting, and storing the cylinder contents regardless of cylinder condition. The type of overpack evaluated is a horizontal "clamshell" vessel (Dubrin et al. 1997). For transportation, a noncompliant cylinder would be placed into an overpack that was already on a truck trailer or railcar. The overpack would be closed and secured, and the shipment would be labeled in accordance with DOT requirements. The overpacks could be reused following shipment.

The second cylinder preparation option for transporting noncompliant cylinders considered in this EIS is the transfer of the DUF_6 from substandard cylinders to new or used cylinders that would meet all DOT requirements. This option could require the construction of a new cylinder transfer facility, for which there are no current plans. Following transfer of the DUF_6, the compliant cylinders could be shipped by placing them directly onto appropriate trucks or railcars.

In this EIS, transportation impacts are estimated for shipment by either truck or rail after cylinder preparation. The impacts are assessed by determining truck and rail routes between ETTP and the Paducah site.

2.2.5 Possible Extension of Conversion Facility Operations and the Potential for Paducah-to-Portsmouth DUF_6 Cylinder Shipments

The conversion facilities at Portsmouth and Paducah are being designed to process the DOE DUF_6 cylinder inventories at these sites over 18 and 25 years, respectively. There are no current plans to operate the conversion facilities beyond these time periods. However, several reasonably foreseeable activities could potentially result in a future decision to extend conversion facility operations at one or both of the sites. These activities are briefly discussed below.

In the future, it is possible that DOE will assume management responsibility for DUF_6 in addition to the current inventory. Two statutory provisions make this possible. First, Sections 161v. [42 USC 2201(v)] and 1311 [42 USC 2297b-10] of the Atomic Energy Act (AEA) of 1954 [P.L. 83-703], as amended, provide that DOE may supply services in support of

USEC. In the past, these provisions were used once to transfer DUF_6 cylinders from USEC to DOE for disposition in accordance with DOE orders, regulations, and policies. Second, Section 3113(a) of the USEC Privatization Act [42 USC 2297h-11(a)] requires DOE to accept LLW, including depleted uranium that has been determined to be LLW, for disposal upon request and reimbursement of costs by USEC or any other person licensed by the NRC to operate a uranium enrichment facility. This provision has not been invoked, and the form in which depleted uranium would be transferred to DOE by a uranium enrichment facility invoking this provision is not specified. However, DOE believes depleted uranium transferred under this provision in the future would most likely be in the form of DUF_6, thus adding to the inventory of material needing conversion at the DUF_6 conversion facilities.

Several possible sources of additional DUF_6 generated from uranium enrichment activities include the following:

1. USEC continues to operate the gaseous diffusion plant at the Paducah site, generating approximately 1,000 cylinders per year of DUF_6. In the past, DOE signed three MOAs with USEC transferring DUF_6 cylinders to DOE (DOE and USEC 1998a,b); the latest was signed in June 2002 for DUF_6 generated from 2002 through 2005. Future MOAs are possible. Consequently, DOE may assume responsibility for additional DUF_6 cylinders at the Paducah site.

2. USEC is currently in the process of developing and demonstrating an advanced enrichment technology based on gas centrifuges. An application for a lead test facility to be operated at the Portsmouth site was submitted to the NRC on February 11, 2003. It is possible that a future enrichment facility using the advanced technology could be sited at either the Paducah or Portsmouth sites. Consequently, additional DUF_6 could be generated at these sites that ultimately could be transferred to DOE.

3. New commercial uranium enrichment facilities may be built and operated in the United States by commercial companies other than USEC. For example, a private company is currently in the process of investigating the feasibility of licensing, building, and operating a gas centrifuge enrichment facility at a location in Tennessee. Although there are no agreements for DOE to accept DUF_6 from such commercial sources, it is possible in the future.

If DOE were to take responsibility for additional DUF_6 in the future, it is reasonable to assume that the conversion facilities could be operated longer than specified in the current plans in order to convert this material. The duration of such extended operations would depend on the quantity of material transferred and the location of the transfer.

In addition, because the Portsmouth facility could conclude operations approximately 7 years before the current Paducah inventory is converted at the Paducah site, it is possible that DUF_6 cylinders could be transferred from Paducah to Portsmouth to facilitate conversion of the entire inventory, particularly if DOE assumes responsibility for additional DUF_6 at Paducah.

The environmental impacts associated with extended plant operations and with Paducah-to-Portsmouth cylinder shipments are discussed in Chapter 5.

2.3 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

2.3.1 Utilization of Commercial Conversion Capacity

During the scoping process for the PEIS, it was suggested that DOE consider using existing UF_6 conversion capacity at commercial nuclear fuel fabrication facilities that convert natural or LEU-UF_6 to UO_2 in lieu of constructing new conversion capacity for DUF_6. Accordingly, in May 2001, DOE investigated the capabilities of existing commercial nuclear fuel fabrication facilities in the United States to determine whether this suggested approach would be a reasonable alternative. Publicly available information was reviewed, and an informal telephone survey of U.S. commercial fuel cycle facilities was conducted. The investigation report concluded that if 100% of the UF_6 conversion capacity of domestic commercial nuclear fuel fabrication facilities operating in May 2001 could be devoted to converting DOE's DUF_6 inventory, approximately 5,500 t (6,000 tons) of DUF_6 could be converted per year. On the basis of this conclusion, the investigation report estimated that it would take more than 125 years to convert DOE's DUF_6 inventory by using only existing conversion capacity. Furthermore, during the informal telephone survey, U.S. commercial fuel fabrication facilities were willing to confirm a capacity of only about 300 t (331 tons) of UF_6 per year as being possibly available to DOE. The investigation report indicated that there seems to be a general lack of interest on the part of the facility owners in committing existing operating or mothballed capacity to conversion of the DOE DUF_6 inventory (Ranek and Monette 2001).

Even though UF_6 conversion capacity at commercial nuclear fuel fabrication facilities might become available in the future, the small capacity identified in 2001 as being possibly available to DOE, coupled with the low interest level expressed at that time by facility owners, indicates that the feasibility of this suggested alternative is low. Therefore, this EIS does not analyze in detail the alternative of using existing capacity at commercial nuclear fuel fabrication facilities.

2.3.2 Other Sites

The consideration of alternative sites was limited to alternative locations within the Paducah site for several reasons. First, P.L. 107-206 identifies Paducah and Portsmouth as the sites for construction of conversion facilities. Second, most of the DUF_6 inventory is located at the Portsmouth and Paducah sites; construction of a conversion facility at a location other than Paducah and/or Portsmouth would require off-site shipment of the entire DUF_6 inventory, consisting of more than 50,000 cylinders. Third, no alternative sites were identified during the public scoping process for constructing and operating conversion facilities. Finally, the generic impacts of conversion at a representative site were already evaluated in the DUF_6 PEIS (DOE 1999a).

2.3.3 Other Conversion Technologies

This EIS provides a detailed analysis of impacts associated with the proposed UDS conversion of DUF_6 to depleted U_3O_8. As discussed in Section 1.6.2.2, the conversion project RFP did not specify the conversion product technology or form. Three proposals submitted in response to the RFP were deemed to be in the competitive range; two of these proposals involved conversion of DUF_6 to U_3O_8 and the third involved conversion to depleted UF_4. Potential environmental impacts associated with these proposals were considered during the procurement process, including the preparation of an environmental critique and environmental synopsis, which were prepared in accordance with the requirements of 10 CFR 1021.216.

The environmental synopsis is presented in Appendix D. The environmental synopsis concluded that, on the basis of assessment of potential environmental impacts presented in the critique, no proposal was clearly environmentally preferable. Although differences in a number of impact areas were identified, none of the differences were considered to result in one proposal being preferable over the others. In addition, the potential environmental impacts associated with the proposals were found to be similar to, and generally less than, those presented in the DUF_6 PEIS (DOE 1999a) for representative conversion technologies.

2.3.4 Long-Term Storage and Disposal Alternatives

This EIS considers the site-specific impacts from conversion operations at the Paducah site, impacts from the transportation of depleted uranium conversion products to NTS and Envirocare for disposal, and impacts from the potential sale of HF and CaF_2 produced from conversion. Environmental impacts are not explicitly evaluated for the long-term storage of conversion products or for disposal.

At this time, there are no specific proposals for the long-term storage of conversion products that would warrant more detailed analysis. Long-term storage alternatives were analyzed in the PEIS, including storage as DUF_6 and storage as an oxide (either U_3O_8 or UO_2). For long-term storage of DUF_6, the options considered were storage in outdoor yards, buildings, and an underground mine. For long-term storage as an oxide, storage in buildings, underground vaults, and an underground mine were considered. The potential environmental impacts from long-term storage were evaluated for representative and generic sites. Preconceptual designs presented in the Engineering Analysis Report (Dubrin et al. 1997) were used as the basis for the analysis, and the evaluation of environmental impacts considered a 40-year period.

This EIS evaluates the impacts from packaging, handling, and transporting conversion products from the conversion facility to a LLW disposal facility. The disposal facility would be (1) selected in a manner consistent with DOE policies and orders and (2) authorized or licensed to receive the conversion products by either DOE (in conformance with DOE orders), the NRC (in conformance with NRC regulations), or an NRC Agreement State agency (in conformance with state laws and regulations determined to be equivalent to NRC regulations). Assessment of the impacts and risks from on-site handling and disposal at the LLW disposal facility is deferred to the disposal site's site-specific NEPA or licensing documents. However, this EIS covers the impacts from transporting the DUF_6 conversion products to both Envirocare and NTS.

2.3.5 Other Transportation Modes

Transportation by air and barge were considered but not analyzed in detail. Transportation by air was deemed to not be reasonable for the types and quantities of materials that would be transported to and from the conversion site. Any transportation by air would involve only small quantities of specialty materials or items generally carried through mail delivery services.

Transportation by barge was also considered, but although it could be used to ship cylinders among the three current storage sites, it was not evaluated in detail. As explained more fully in Section 4.1 of the Engineering Analysis Report (Dubrin et al. 1997), ETTP is the only site with a functioning barge facility. Paducah would either have to build new facilities or use existing facilities that are located 20 to 30 mi (32 to 48 km) from the Paducah site. Use of existing facilities would require on-land transport by truck or rail over the 20- to 30-mi (32- to 48-km) distance, and the cylinders would have to go through one extra unloading/loading step at the end of the barge transport. Currently, there are no initiatives to build new barge facilities closer to the Paducah site. The closest distance to the Ohio River from the Paducah site is 6 mi (10 km). Therefore, even if a new barge facility was built, on-land transport of cylinders and an extra unloading/loading step would still be required at this site. If barge shipment was proposed in the future, additional environmental review might be required.

2.3.6 One Conversion Plant Alternative

In the NOI published in the *Federal Register* on September 18, 2001, construction and operation of one conversion plant was identified as a preliminary alternative that would be considered in the conversion EIS. However, with the passage of P.L. 107-206, which mandates the construction and operation of conversion facilities at both Paducah and Portsmouth, the one conversion plant alternative was considered but not analyzed in this EIS.

2.4 COMPARISON OF ALTERNATIVES

2.4.1 General

This draft EIS includes analyses of a no action alternative and the proposed action of building and operating a conversion facility at three alternative locations within the Paducah site. Listed below is a general comparison of the activities required for each alternative and the types of environmental impacts that could be expected from each. A detailed comparison of the estimated environmental impacts associated with the alternatives is provided in Section 2.4.2.

- The no action alternative would consist of the continued surveillance and maintenance of the DUF_6 inventory at the Paducah site. No conversion facility would be constructed or operated. Only minor yard reconstruction would be required, and no cylinders would be shipped off site. Cylinder breaches could occur as a result of damage during handling or external corrosion.

  Potential environmental impacts associated with the no action alternative would be primarily limited to (1) the exposure of involved workers to external radiation in the cylinder yards during surveillance and maintenance activities, (2) impacts from reconstruction of three cylinder yards, (3) impacts associated with the possible release of depleted uranium and HF from breached cylinders and their dispersal in the environment (before the breaches were identified and repaired), and (4) potential accidents that could damage cylinders and result in a release of DUF_6.

- The proposed action would involve the construction and operation of a conversion facility at Paducah. Three alternative locations are considered. It would take the conversion facility approximately 25 years to convert the entire DUF_6 inventory to U_3O_8 at a rate of approximately 1,400 cylinders (18,000 t [20,000 tons]) per year. Aqueous HF could also be produced for sale during the conversion process, or the HF could be neutralized to CaF_2 for sale or disposal.

  The option of shipping approximately 6,400 cylinders (approximately 4,800 DUF_6 cylinders for conversion and about 1,600 non-DUF_6 cylinders) from ETTP to Paducah is also evaluated. This option would extend the period of operation from 25 to 28 years.

  After conversion, the conversion products (U_3O_8, aqueous HF or CaF_2, and emptied cylinders, if not used as disposal containers for U_3O_8) would be shipped by truck or rail to a user or disposal facility (likely NTS or Envirocare).

  Potential environmental impacts associated with the proposed action alternatives would include (1) impacts to local air, water, soil, ecological, and cultural resources during conversion facility construction; (2) impacts to workers from facility construction and operations; (3) impacts from small amounts of depleted uranium and other hazardous compounds released to the environment through normal conversion plant air effluents; (4) impacts from the shipment of cylinders, conversion products, and waste products; and (5) impacts from potential accidents involving the release of radioactive material or hazardous chemicals.

2.4.2 Summary and Comparison of Potential Environmental Impacts

This draft EIS includes analyses of potential impacts at the Paducah site under the no action alternative and the proposed action alternatives. Under the no action alternative, potential impacts associated with the continued storage of DUF_6 cylinders in yards are evaluated through 2039; in addition, the long-term impacts that could result from releases of DUF_6 and HF from future cylinder breaches are evaluated. For the proposed action, potential impacts are evaluated at three alternative locations for the following:

- The conversion facility construction period of approximately 2 years;
- The operational period required to convert the Paducah DUF_6 inventory, which would equal 25 years (28 years if the ETTP inventory was shipped to Paducah instead); and
- A facility D&D period of 3 years.

Under each alternative, potential consequences are evaluated in many areas: human health and safety (during normal operations, accidents, and transportation), air quality, noise, water, soil, socioeconomics, ecology, waste management, resource requirements, land use, cultural resources, and environmental justice. (Methodologies are discussed in Chapter 4 and Appendix F.) The assessment considers impacts that could result from the construction of necessary facilities, normal operations of facilities, accidents, preparation of cylinders for shipment, transportation of materials, and the D&D of facilities after conversion is complete. In addition, the production and sale of aqueous HF is evaluated, as is the possibility of neutralizing HF to CaF_2 for sale or disposal.

The potential environmental impacts at Paducah under the action alternatives and the no action alternative are presented in Table 2.4-1 (placed at the end of this chapter). To supplement the information in Table 2.4-1, each area of impact evaluated in the EIS is discussed below. Major similarities and differences among the alternatives are highlighted. Additional details and discussion are provided in Chapter 5 for each alternative.

2.4.2.1 Human Health and Safety — Construction and Normal Facility Operations

Under the no action alternative and the action alternatives, it is estimated that potential exposures of workers and members of the public to radiation and chemicals would be well within applicable public health standards and regulations during normal facility operations. The estimated doses and risks from radiation and/or chemical exposures of the general public and noninvolved workers would be very low, with zero latent cancer fatalities (LCFs) expected among these groups over the time periods considered, and with no adverse health impacts from chemical exposures expected. (Dose and risk estimates are shown in Table 2.4-1.) In general, the location of a conversion facility within the Paducah site would not significantly affect potential impacts to workers or the public during normal facility operations (i.e., no significant differences in impacts were identified at alternative Locations A, B, or C). Construction workers at

Locations A and C and cylinder yard reconstruction workers under the no action alternative would receive low doses (i.e., up to 40 mrem/yr for the action alternatives and up to 230 mrem/yr for the no action alternative) because of the proximity of the construction sites to the cylinder yards.

Involved workers (persons directly involved in the handling of radioactive or hazardous materials) could be exposed to low-level radiation emitted by uranium during the normal course of their work activities, and this exposure could result in a slight increase in the risk for radiation-induced LCFs to individual involved workers. (The possible presence of TRU and Tc contamination in the cylinder inventory would not contribute to exposures during normal operations.) The annual number of workers exposed could range from about 40 (under the no action alternative) to 140 under the action alternatives. Under the no action alternative, it is estimated that radiation exposure of involved workers would result in a 1-in-2 chance of one additional LCF among the entire involved worker population over the life of the project. Under the action alternatives, a 1-in-7 chance of one additional LCF among involved workers over the life of the project was estimated.

Possible radiological exposures from using groundwater potentially contaminated as a result of releases from breached cylinders or facility releases were also evaluated. In general, these exposures would be at very low levels and within applicable public health standards and regulations. However, the uranium concentration in groundwater could exceed 20 μg/L at some time in the future under the no action alternative if cylinder corrosion was not controlled. This scenario is highly unlikely because ongoing cylinder inspections and maintenance would prevent significant releases from occurring.

2.4.2.2 Human Health and Safety — Facility Accidents

2.4.2.2.1 Physical Hazards. Under all alternatives, workers could be injured or killed as a result of on-the-job accidents unrelated to radiation or chemical exposure. On the basis of accident statistics for similar industries, it is estimated that under the no action alternative, zero fatalities and about 84 injuries might occur through 2039 at the Paducah site (about 2 injuries per year). Under the action alternatives, the risk of physical hazards would not depend on the location of the conversion facility. No fatalities are predicted, but about 11 injuries during construction and about 200 injuries during operations could occur at the conversion facility (about 6 injuries per year during a 2-year construction period and 8 injuries per year during operations). Accidental injuries and deaths are not unusual in industries that use heavy equipment to manipulate weighty objects and bulk materials.

2.4.2.2.2 Facility Accidents Involving Radiation or Chemical Releases. Under all alternatives, it is possible that accidents could release radiation or chemicals to the environment, potentially affecting workers and members of the public. Of all the accidents considered, those involving DUF_6 cylinders and those involving chemicals at the conversion facility would have the largest potential effects.

Under all alternatives, accidents involving DUF_6 cylinders could occur at the current storage locations. Cylinder accidents could release DUF_6 to the environment. If a release occurred, the DUF_6 would combine with moisture in the air, forming gaseous HF and UO_2F_2, a soluble solid in the form of small particles. The depleted uranium and HF could be dispersed downwind, potentially exposing workers and members of the general public to radiation and chemical effects. The amount released would depend on the severity of the accident and the number of cylinders involved. The probability of cylinder accidents would decrease under the action alternatives as the DUF_6 was converted and the number of cylinders in storage decreased as a result.

For releases involving DUF_6 and other uranium compounds, both chemical and radiological effects could occur if the material was ingested or inhaled. The chemical effect of most concern associated with internal uranium exposure is kidney damage, and the radiological effect of concern is an increase in the probability of developing cancer. With regard to uranium, chemical effects occur at lower exposure levels than do radiological effects. Exposure to HF from accidental releases could result in a range of health effects, from eye and respiratory irritation to death, depending on the exposure level. Large anhydrous NH_3 releases could also cause severe respiratory irritation and death. (NH_3 is used to generate hydrogen, which is required for the conversion process.)

Chemical and radiological exposures to involved workers (those within 100 m [329 ft] of the release) under accident conditions would depend on how rapidly the accident developed, the exact location and response of the workers, the direction and amount of the release, the physical forces causing or caused by the accident, meteorological conditions, and the characteristics of the room or building if the accident occurred indoors. Impacts to involved workers under accident conditions would likely be dominated by physical forces from the accident itself; thus quantitative dose/effect estimates would not be meaningful. For these reasons, the impacts to involved workers during accidents are not quantified in this EIS. However, it is recognized that injuries and fatalities among involved workers would be possible if an accident did occur.

Under the no action alternative, for accidents involving cylinders that might happen at least once in 100 years (i.e., likely accidents [see Section 5.1.2.1.2]), it is estimated that the off-site concentrations of HF and uranium would be considerably below levels that would cause adverse chemical effects among members of the general public from exposure to these chemicals. However, up to 10 noninvolved workers might experience potential adverse effects from exposure to HF and uranium (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function). It is estimated that one noninvolved worker might experience potential irreversible adverse effects that are permanent in nature (such as lung damage or kidney damage), with no fatalities expected. Radiation exposures would be unlikely to result in additional LCFs among noninvolved workers or members of the general public for these types of accidents.

Cylinder accidents that are less likely to occur could be more severe, having greater consequences that could potentially affect off-site members of the general public. These types of accidents are considered extremely unlikely, expected to occur with a frequency of between once in 10,000 years and once in 1 million years of operations. Through 2039, the probability of this type of accident would be about 1 chance in 2,500. Among all the cylinder accidents analyzed, the postulated accident that would result in the largest number of people with adverse effects (including mild and temporary as well as permanent effects) would be an accident that involves rupture of cylinders in a fire. If this type of accident occurred at the Paducah site, it is estimated that up to 2,000 members of the general public and 910 noninvolved workers might experience adverse chemical effects from HF and uranium exposure (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function). It is estimated that more adverse effects would occur among the general public than among noninvolved workers because of the buoyancy effects from the fire on contaminant plume spread (i.e., the concentrations that would occur would be higher at points farther from the release than at closer locations).

The postulated cylinder accident that would result in the largest number of persons with irreversible adverse health effects is a corroded cylinder spill under wet conditions. If this accident occurred, it is estimated that 1 member of the general public and 300 noninvolved workers might experience irreversible adverse effects (such as lung damage or kidney damage). No fatalities are expected among the members of the general public; there would be a potential for three fatalities among noninvolved workers from chemical effects. Radiation exposures would be unlikely to result in additional LCFs among noninvolved workers (1 chance in 170) or the general public (1 chance in 70).

In addition to the cylinder accidents discussed above is a certain class of accidents that the DOE investigated; however, because of security concerns, information about such accidents is not available for public review but is presented in a classified appendix to the EIS. All classified information will be presented to appropriate state and local officials for their review and comment.

The number of persons actually experiencing adverse or irreversible adverse effects from cylinder accidents would likely be considerably fewer than those estimated for this analysis and would depend on the actual circumstances of the accident and the individual chemical sensitivities of the affected persons. For example, although exposures to releases from cylinder accidents could be life-threatening (especially with respect to immediate effects from HF inhalation), the guideline exposure level of 20 parts per million (ppm) of HF used to estimate the potential for irreversible adverse effects from HF exposure is likely to result in overestimates. This is because no animal or human deaths have been known to occur as a result of acute exposures (i.e., 1 hour or less) at concentrations of less than 50 ppm; generally, if death does not occur quickly after HF exposure, recovery is complete.

Similarly, the guideline intake level of 30 mg used to estimate the potential for irreversible adverse effects from the intake of uranium in this EIS is the level suggested in NRC guidance. This level is somewhat conservative; that is, it is intended to overestimate rather than underestimate the potential number of irreversible adverse effects in the exposed population following uranium exposure. In more than 40 years of cylinder handling activities, no accidents involving releases from cylinders containing *solid* UF_6 have occurred that have caused diagnosable irreversible adverse effects among workers. In previous accidental exposure incidents involving *liquid* UF_6 in gaseous diffusion plants, some worker fatalities occurred immediately after the accident as a result of inhalation of HF generated from the UF_6. However, no fatalities occurred as a result of the toxicity of the uranium exposure. A few workers were exposed to amounts of uranium estimated to be about three times the guideline level (30 mg) used for assessing irreversible adverse effects; none of these workers, however, actually experienced such effects.

Under the action alternatives, low-probability accidents involving chemicals at the conversion facility could have large potential consequences for noninvolved workers and members of the public. At a conversion site, accidents involving chemical releases, such as NH_3 and HF, could occur. NH_3 is used to generate hydrogen for conversion, and HF can be produced as a co-product of converting DUF_6. Although the use of NH_3 for hydrogen production is currently part of the UDS design, the use of natural gas for hydrogen production, which would eliminate the need for NH_3, is being investigated.

The conversion accident estimated to have the largest potential consequences is an accident involving the rupture of an anhydrous NH_3 tank. Such an accident could be caused by a large earthquake and is expected to occur with a frequency of less than once in 1 million years per year of operations. The probability of this type of accident occurring during the operation of a conversion facility is a function of the period of operation; over 25 years of operations, the accident probability would be less than 1 chance in 40,000.

If an NH_3 tank ruptured at the conversion facility, a maximum of up to about 6,700 members of the general public might experience adverse effects (mild and temporary effects, such as respiratory irritation or temporary decrease in kidney function) as a result of chemical exposure. A maximum of about 370 people might experience irreversible adverse effects (such as lung damage or kidney damage), with the potential for about 7 fatalities. With regard to noninvolved workers, up to about 1,600 workers might experience adverse effects (mild and temporary) as a result of chemical exposures. A maximum of about 1,600 noninvolved workers might experience irreversible adverse effects, with the potential for about 30 fatalities.

The location of the conversion facility within the Paducah site would affect the number of noninvolved workers who might experience adverse or irreversible adverse effects from an NH_3 tank rupture accident. However, the accident analyses indicate that the impacts would not be consistently higher or lower at any of the alternative locations.

Although such high-consequence accidents at a conversion facility are possible, they are expected to be extremely rare. The risk (defined as consequence × probability) for these accidents would be zero fatalities and zero irreversible adverse health effects expected for noninvolved workers and members of the public combined. NH_3 and HF are commonly used for industrial applications in the United States, and there are well-established accident prevention and mitigative measures for HF and NH_3 storage tanks. These include storage tank siting principles, design recommendations, spill detection measures, and containment measures. These measures would be implemented, as appropriate.

Under the action alternatives, the highest consequence radiological accident is estimated to be an earthquake damaging the depleted U_3O_8 product storage building. If this accident occurred, it is estimated that about 180 lb (82 kg) of depleted U_3O_8 would be released to the atmosphere outside of the building. The collective dose received by the general public and the noninvolved workers would be about 70 person-rem and 500 person-rem, respectively. There would be about a 1-in-40 chance of an LCF among the public and a 1-in-5 chance of an LCF among the noninvolved workers. Because the accident has a probability of occurrence that is about 1 chance in 4,000, the risk posed by the accident would be essentially zero LCFs among both the public and the workers.

2.4.2.3 Human Health and Safety — Transportation

Under the no action alternative, only small amounts of the LLW and LLMW that would be generated during routine cylinder maintenance activities would require transportation (about one shipment per year). Only negligible impacts are expected from such shipments. No DUF_6 or non-DUF_6 cylinders would be transported between sites.

Under the action alternatives, the number of shipments would include the following:

1. Approximately 16,400 truck shipments or 4,100 railcar shipments of depleted U_3O_8 from the conversion facility to Envirocare or NTS, if U_3O_8 was disposed of in bulk bags. The numbers of shipments would be about 18,000 for trucks or 7,200 for railcars if the emptied cylinders were used as disposal containers.

2. About 15,000 truck or 4,000 railcar shipments of aqueous (70% and 49%) HF could occur; alternatively, the aqueous HF could be neutralized to CaF_2, requiring a total of about 25,000 truck or 6,300 railcar shipments. Currently, the destination for these shipments is not known.

3. About 1,300 truck or 650 railcar shipments of anhydrous NH_3 from a supplier to the site. Currently, the origin of these shipments is not known.

4. Emptied heel cylinders to Envirocare or NTS, if bulk bags were used to dispose of the depleted U_3O_8.

5. For the option of shipping ETTP cylinders to Paducah, approximately 5,400 truck or 1,400 railcar shipments of cylinders from ETTP.

During normal transportation operations, radioactive material and chemicals would be contained within their transport packages. Health impacts to crew members (i.e., workers) and members of the general public along the routes could occur if they were exposed to low-level external radiation in the vicinity of uranium material shipments. In addition, exposure to vehicle emissions (engine exhaust and fugitive dust) could potentially cause latent fatalities from inhalation.

The risk estimates for emissions are based on epidemiological data that associate mortality rates with particulate concentrations in ambient air. (Increased latent mortality rates resulting from cardiovascular and pulmonary diseases have been linked to incremental increases in particulate concentrations.) Thus, the increase in ambient air particulate concentrations caused by a transport vehicle, with its associated fugitive dust and diesel exhaust emissions, is related to such premature latent fatalities in the form of risk factors. Because of the conservatism of the assumptions made to reconcile results among independent epidemiological studies and associated uncertainties, the latent fatality risks estimated for normal vehicle emissions should be considered to be an upper bound (Biwer and Butler 1999).[2] For the transport of conversion products and co-products (depleted U_3O_8, aqueous HF, and emptied cylinders, if not used as disposal containers), it is conservatively estimated that a total of about 12 fatalities from vehicle emissions could occur if shipments were only by truck and if aqueous HF product was sold and transported 620 mi (1,000 km) from the site (about 20 fatalities are estimated if HF was neutralized to CaF_2 and transported 620 mi [1,000 km]) from the site. The number of fatalities occurring from exhaust emissions if shipments were only by rail would be less than 1 if HF was sold and about 1 if the HF was neutralized to CaF_2.

Exposure to external radiation during normal transportation operations is estimated to cause less than 1 LCF under both truck and rail options. Members of the general public living along truck and rail transportation routes would receive extremely small doses of radiation from shipments, less than 0.1 mrem over the duration of the program. This would be true even if a single person was exposed to every shipment of radioactive material during the program.

Traffic accidents could occur during the transportation of radioactive materials and chemicals. These accidents could potentially affect the health of workers (i.e., crew members) and members of the general public, either from the accident itself or from accidental releases of radioactive materials or chemicals.

The total number of traffic fatalities (unrelated to the type of cargo) was estimated on the basis of national traffic statistics for shipments by both truck and rail. If the aqueous HF was sold to users about 620 mi (1,000 km) from the site, about 1 traffic fatality would be estimated under both transportation modes. If HF was neutralized to CaF_2, about 3 fatalities would be estimated for the truck option, and 1 fatality for the rail option.

Severe transportation accidents could also result in a release of radioactive material or chemicals from a shipment. The consequences of such a release would depend on the material released, location of the accident, and atmospheric conditions at the time. Potential consequences would be greatest in urban areas because more people could be exposed. Accidents that occurred when atmospheric conditions were very stable (typical of nighttime) would have higher potential consequences than accidents that occurred when conditions were unstable (i.e., turbulent, typical of daytime) because the stability would determine how quickly the released material dispersed and diluted to lower concentrations as it moved downwind.

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2 For perspective, in a recently published EIS for a geologic repository at Yucca Mountain, Nevada (DOE 2002h), the same risk factors were used for vehicle emissions; however, they were adjusted to reduce the amount of conservatism in the estimated health impacts. As reported in the Yucca Mountain EIS, the adjustments resulted in a reduction in the emission risks by a factor of about 30.

For the action alternatives, the highest potential accident consequences during transportation activities would be caused by a rail accident involving anhydrous NH_3. Although anhydrous NH_3 is a hazardous gas, it has many industrial applications and is commonly safely transported by industry as a pressurized liquid in trucks and rail tank cars.

The probability of a severe anhydrous NH_3 railcar accident occurring in a highly populated urban area under stable atmospheric conditions is extremely rare. The probability of such an accident occurring if all the anhydrous NH_3 needed was transported 620 mi (1,000 km) is estimated to be less than 1 chance in 200,000. Nonetheless, if such an accident (i.e., release of anhydrous NH_3 from a railcar in a densely populated urban area under stable atmospheric conditions) occurred, up to 5,000 persons might experience irreversible adverse effects (such as lung damage), with the potential for about 100 fatalities. If the same type of NH_3 rail accident occurred in a typical rural area, which would have a smaller population density than an urban area, potential impacts would be considerably less. It is estimated that in a rural area, approximately 20 persons might experience irreversible adverse effects, with no expected fatalities. The atmospheric conditions at the time of an accident would also significantly affect the consequences of a severe NH_3 accident. The consequences of an NH_3 accident would be less severe under unstable conditions, the most likely conditions in the daytime. Unstable conditions would result in more rapid dispersion of the airborne NH_3 plume and lower downwind concentrations. Under unstable conditions in an urban area, approximately 400 persons could experience irreversible adverse effects, with the potential for about 8 fatalities. If the accident occurred in a rural area under unstable conditions, 1 person would be expected to experience an irreversible adverse effect, with zero fatalities expected. When the probability of an NH_3 accident occurring is taken into account, it is expected that no irreversible adverse effects and no fatalities would occur over the shipment period.

For perspective, anhydrous NH_3 is routinely shipped commercially in the United States for industrial and agricultural applications. On the basis of information provided in the DOT *Hazardous Material Incident System (HMIS) Database* (DOT 2003b), for 1990 through 2002, 2 fatalities and 19 major injuries to the public or to transportation or emergency response personnel have occurred as a result of anhydrous NH_3 releases during truck and rail operations. These fatalities and injuries occurred during transportation or loading and unloading operations. Over that period, truck and rail NH_3 spills resulted in more than 1,000 and 6,000 evacuations, respectively. Five very large spills, more than 10,000 gal (38,000 L), have occurred; however, these spills were all en-route derailments from large rail tank cars. The two largest spills, both around 20,000 gal (76,000 L), occurred in rural or lightly populated areas and resulted in one major injury. Over the past 30 years, the safety record for transporting anhydrous NH_3 has significantly improved. Safety measures contributing to this improved safety record include the installation of protective devices on railcars, fewer derailments, closer manufacturer supervision of container inspections, and participation of shippers in the Chemical Transportation Emergency Center.

After anhydrous NH_3, the types of accidents that are estimated to result in the second highest consequences are those involving shipment of 70% aqueous HF produced during the conversion process. The estimated numbers of irreversible adverse effects for 70% HF rail accidents are about one-third of those from the anhydrous NH_3 accidents. However, the number of estimated fatalities is about one-sixth of those from NH_3 accidents, because the percent of fatalities among the individuals experiencing irreversible adverse effects is 1% as opposed to 2% for NH_3 exposures (Policastro et al. 1997). For perspective, since 1971, the period covered by DOT records, no fatal or serious injuries to the public or to transportation or emergency response personnel have occurred as a result of anhydrous HF releases during transportation. (Most of the HF transported in the United States is anhydrous HF, which is more hazardous than aqueous HF.) Over that period, 11 releases from railcars were reported to have no evacuations or injuries associated with them. The only major release (estimated at 6,400 lb [29,000 kg] of HF) occurred in 1985 and resulted in approximately 100 minor injuries. Another minor HF release during transportation occurred in 1990. The safety record for transporting anhydrous HF has improved in the past 10 years for the same reasons as those discussed above for NH_3.

2.4.2.4 Air Quality and Noise

Under the no action alternative, air quality from construction and operations would be within national and state ambient air quality standards. However, estimated concentrations of particulate matter (PM) that could be generated during yard reconstruction activities at Paducah would be close to the regulatory standards; these temporary emissions could be controlled by good construction practices. Continued cylinder maintenance and painting are expected to be effective in controlling corrosion, and concentrations of HF would be kept within regulatory standards at the Paducah site.

Under the action alternatives, it was found that air quality impacts during construction would be similar for all three alternative locations. The total (modeled plus the measured background value representative of the site) concentrations due to emissions of most criteria pollutants — such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO) — would be well within applicable air quality standards. As is often the case for construction, the primary concern would be PM released from near-ground-level sources. Total concentrations of PM_{10} and $PM_{2.5}$ (PM with a mean aerodynamic diameter of 10 µm or less and 2.5 µm or less, respectively) at the construction site boundary would be close to or above the standards because of the high background concentrations and the proposed facility's proximity to potentially publicly accessible areas. Accordingly, construction activities should be conducted so as to minimize further impacts on ambient air quality. To mitigate impacts, water could be sprayed on disturbed areas more often, and dust suppressant or pavement could be applied to roads with frequent traffic.

During operations, it is estimated that total concentrations for all criteria pollutants (except for $PM_{2.5}$) would be well within standards. The background level of annual average $PM_{2.5}$ in the area of the Paducah site approaches the standard. Again, impacts during operations were found to be similar for all three alternative locations.

Noise impacts are expected to be negligible under the no action alternative. Under the action alternatives, estimated noise levels at the nearest residence (located 1.3 km [0.8 mi] from the construction location) would be below the U.S. Environmental Protection Agency (EPA) guideline of 55 dB(A)[3] as day-night average sound level (DNL)[4] for residential zones during construction and operations.

2.4.2.5 Water and Soil

Under the no action alternative, uranium concentrations in surface water, groundwater, and soil would remain below guidelines throughout the project duration. However, if cylinder maintenance and painting were not effective in reducing cylinder corrosion rates, the uranium concentration in groundwater could be greater than the guideline at some time in the future (no earlier than about 2100). If continued cylinder maintenance and painting were effective in controlling corrosion, as expected, groundwater uranium concentrations would remain less than the guideline.

During construction of the conversion facility, construction material spills could contaminate surface water, groundwater, or soil. However, by implementing storm water management, erosion control, and good construction practices, concentrations in soil and wastewater (and therefore surface water and groundwater) could be kept well within applicable standards or guidelines.

During operations, no appreciable impacts on surface water or groundwater would result from the conversion facility because no contaminated liquid effluents are anticipated, and because airborne emissions would be at very low levels (e.g., <0.25 g/yr of uranium). Impacts would be similar for all three alternative locations.

Contaminated soil associated with solid waste management unit (SWMU) 194 could be excavated during construction at Locations A and C. these soils would be managed as described in Section 2.4.2.8.

2.4.2.6 Socioeconomics

The socioeconomic analysis evaluates the effects of construction and operation on population, employment, income, regional growth, housing, and community resources in the region of influence (ROI) around the site. In general, socioeconomic impacts tend to be positive, creating jobs and income, with only minor impacts on housing, public finances, and employment in local public services.

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3 dB(A) is a unit of weighted sound-pressure level, measured by the use of the metering characteristics and the A-weighting specified in the *American National Standard Specification for Sound Level Meters*, ANSI S1.4-1983, and in Amendment S1.4A-1985 (Acoustical Society of America 1983, 1985).

4 DNL is the 24-hour average sound level, expressed in dB(A), with a 10-dB penalty artificially added to the nighttime (10 p.m.–7 a.m.) sound level to account for noise-sensitive activities (e.g., sleep) during these hours.

The no action alternative would result in a small socioeconomic impact, creating 110 jobs during cylinder yard reconstruction (over 2 construction years) and 130 jobs during operations (direct and indirect jobs) and generating $3.7 million during construction and $4.3 million in personal income per operational year. No significant impacts on regional growth and housing, local finances, and public service employment in the ROI are expected.

Under the action alternatives, jobs and direct income would be generated during both construction and operation. Construction of the conversion facility would create 320 jobs and generate $12 million in personal income in the peak construction year (construction occurs over a 2-year period). Operation of the conversion facility would create 350 jobs and generate $14 million in personal income each year. Only minor impacts on regional growth and housing, local finances, and public service employment in the ROI are expected. The socioeconomic impacts would not depend on the location of the conversion facility; therefore, the impacts would be the same for alternative Locations A, B, and C.

2.4.2.7 Ecology

Under the no action alternative, continued cylinder maintenance and surveillance activities would have negligible impacts on ecological resources (i.e., vegetation, wildlife, wetlands, and threatened and endangered species). Only a small amount of yard reconstruction, in a previously disturbed area, would occur at the Paducah site. It is estimated that potential concentrations of contaminants in the environment from future cylinder breaches would be below levels harmful to biota. However, there is a potential for impacts to aquatic biota from cylinder yard runoff during painting activities.

Under the action alternatives, the total area disturbed during conversion facility construction would be 45 acres (18 ha). Vegetative communities would be impacted in this area from a loss of habitat. However, for all three alternative locations, impacts could be minimized depending on exactly where the facility was placed within each location. These habitat losses would constitute less than 1% of available land at the site. It was found that concentrations of contaminants in the environment during operations would be below harmful levels. Impacts to vegetation and wildlife would be negligible are at all three locations.

Wetlands at or near Locations A, B, and C could be adversely affected at the Paducah site. Impacts to wetlands could be minimized depending on where exactly the facility was placed within each location. Unavoidable impacts to wetlands would require a Clean Water Act (CWA) Section 404 Permit from the U.S. Army Corps of Engineers (USACE) and CWA Section 401 water quality certification from the Commonwealth of Kentucky. Mitigative measures, possibly including compensatory mitigation, might be stipulated in these permits. A mitigation plan might be required prior to the initiation of construction.

Construction of the conversion facility in the eastern portion of Location C could impact potential habitat for cream wild indigo (state-listed as a species of special concern) and compass plant (state-listed as threatened). For construction at all three locations, impacts on deciduous forest might occur. Impacts to forested areas could be avoided if temporary construction areas were placed in previously disturbed locations. Trees with exfoliating bark, such as shagbark hickory, or dead trees with loose bark can be used by the Indiana bat (federal- and state-listed as endangered) as roosting trees during the summer. If either live or dead trees with exfoliating or loose bark are encountered on construction areas, they should be saved if possible. If necessary, the trees should be cut before April 15 or after September 15.

2.4.2.8 Waste Management

Under the no action alternative, LLW and LLMW would be generated from cylinder scraping and painting activities. The amount of LLMW generated could represent an increase of less than 1% in the site's LLMW load, representing a negligible impact on site waste management operations.

Under the action alternatives, waste management impacts would not be dependent on the location of the conversion facility within the site and would be the same for alternative Locations A, B, and C. Waste generated during construction and operations would have negligible impacts on the Paducah site waste management operations, with the exception of possible impacts from disposal of CaF_2. Industrial experience indicates that HF, if produced, would contain only trace amounts of depleted uranium (less than 1 ppm). It is expected that HF would be sold for use. If sold for use, the sale would be subject to review and approval by DOE in coordination with the NRC, depending on the specific use (as discussed in Appendix E).

The U_3O_8 produced during conversion would generate about 7,850 yd^3 (6,000 m^3) per year of LLW. This is 83% of Paducah's annual projected LLW volume and could have potentially large impacts on site LLW management. However, plans for off-site disposal of this LLW are included in the proposed action.

If the HF was not sold but instead neutralized to CaF_2, it is currently unknown whether (1) the CaF_2 could be sold, (2) the low uranium content would allow the CaF_2 to be disposed of as nonhazardous solid waste, or (3) disposal as LLW would be required. The low level of uranium contamination expected (i.e., less than 1 ppm) suggests that sale or disposal as nonhazardous solid waste would be most likely. If sold for use, the sale would be subject to review and approval by DOE in coordination with the NRC, depending on the specific use. Waste management for disposal as nonhazardous waste could be handled through appropriate planning and design of the facilities. If the CaF_2 had to be disposed of as LLW, it could represent a potentially large impact on waste management operations.

A small quantity of TRU could be entrained in the gaseous DUF_6 during the cylinder emptying operations. These contaminants would be captured in the filters between the cylinders and the conversion equipment. The filters would be monitored and replaced routinely to prevent buildup of TRU. The spent filters would be disposed of as LLW, generating up to 25 drums of LLW over the life of the project.

Current UDS plans are to leave the heels in the emptied cylinders, add a stabilizer, and either (1) crush the cylinders and dispose of them at either Envirocare or NTS or (2) use the cylinders as disposal containers for the U_3O_8 product. Either one of these approaches is expected to meet the waste acceptance criteria of the disposal facilities and minimize the potential for generating TRU waste through washing of the cylinders to remove the heels. Although cylinder washing is not considered a foreseeable option at this time, for completeness, an analysis of the maximum potential quantities of TRU waste that could be generated from cylinder washing is included in Appendix B.

In addition, potentially contaminated soil associated with SWMU 194 could be excavated during construction at Locations A and B. The excavated soil would be managed consistent with RCRA regulations and coordinated between the Commonwealth of Kentucky (Division of Waste Management) and DOE.

2.4.2.9 Resource Requirements

Resource requirements include construction materials, fuel, electricity, process chemicals, and containers. In general, all alternatives would have a negligible effect on the local or national availability of these resources.

2.4.2.10 Land Use

Under the no action alternative, all activities would occur in areas previously used for conducting similar activities; therefore, no land use impacts are expected. Under the action alternatives, a total of 45 acres (18 ha) could be disturbed, with some areas cleared for railroad or utility access and not adjacent to the site. All three alternative locations are within an already-industrialized facility, and impacts to land use would be similar for the three alternative locations. The permanently altered areas would represent less than 1% of available land already developed for industrial purposes. Negligible impacts on land use are thus expected.

2.4.2.11 Cultural Resources

Under the no action alternative, impacts on cultural resources at the current storage locations would be unlikely because all activities would occur in areas already dedicated to cylinder storage. Under the action alternatives, impacts on cultural resources would be possible at all three alternative locations. Archaeological and architectural surveys have not been completed for the candidate locations and would have to be undertaken prior to initiation of the action alternatives. If archaeological resources were encountered, or historical or traditional cultural properties were identified, a mitigation plan would be required.

2.4.2.12 Environmental Justice

No disproportionately high and adverse human health or environmental impacts are expected to minority or low-income populations during normal facility operations under the action alternatives. Although the consequences of facility accidents could be high if severe accidents occurred, the risk of irreversible adverse effects (including fatalities) among members of the general public from these accidents (taking into account the consequences and probability of the accidents) would be less than 1. Furthermore, transportation accidents with high and adverse impacts are unlikely; their locations cannot be projected, and the types of persons who would be involved cannot be reliably predicted. Thus, there is no reason to expect that minority and low-income populations would be affected disproportionately by high and adverse impacts.

2.4.2.13 Option of Shipping ETTP Cylinders to Paducah

If cylinders from ETTP were transported to Paducah, the cylinders would have to be prepared to be shipped by either truck or rail. Approximately 4,800 DUF_6 cylinders for conversion and about 1,600 non-DUF_6 cylinders would require preparation for shipment at ETTP. As discussed in Chapter 5 in this EIS, two cylinder preparation methods are considered for the shipment of noncompliant cylinders: use of cylinder overpacks and cylinder transfer.

In general, the use of cylinder overpacks would result in small potential impacts. Overpacking operations would be similar to current cylinder handling operations, and impacts would be limited to involved workers. No LCFs among involved workers from radiation exposure are expected.

The use of a cylinder transfer facility would likely require the construction of a new facility at ETTP; there are no current plans to build such a facility. Operational impacts would generally be small and limited primarily to external radiation exposure of involved workers, with no LCFs expected. Transfer facility operations would generate a large number of emptied cylinders requiring disposition.

Impacts from extended operations of the conversion plant from 25 to 28 years would not be expected to significantly increase overall impacts.

2.4.2.14 Impacts Associated with Conversion Product Sale and Use

During the conversion of the DUF_6 inventory to depleted U_3O_8, products having some potential for reuse would be produced. These products would include HF and CaF_2, which are commonly used as commercial materials. An investigation of the potential reuse of HF and CaF_2 is included as part of this EIS (Chapter 5 and Appendix E). Areas examined include the characteristics of these materials as produced within the conversion process, the current markets for these products, and the potential socioeconomic impacts should these products be provided to the commercial sector. Because there would be some residual radioactivity associated with these materials, the DOE process for authorizing release of materials for unrestricted use (referred to as “free release”) and an estimate of the potential human health effects of such free release are also considered in this investigation. The results of the analysis of HF and CaF_2 use are included in Table 2.4-1.

If the products were to be released for restricted use (e.g., in the nuclear industry for the manufacture of nuclear fuel), the impacts would be less than those for unrestricted release.

Conservative estimates of the amount of uranium and technetium that might transfer into the HF and CaF_2 were used to evaluate the maximum expected dose to workers using the material if it was released for commercial use. On the basis of very conservative assumptions concerning use, the maximum dose to workers or the general public was estimated to be less than 1 mrem/yr, much less than the regulatory limit of 100 mrem/yr specified for members of the general public. Doses to the general public would be even lower.

Socioeconomic impact analyses were conducted to evaluate the impacts of the introduction of the conversion-produced HF or CaF_2 into the commercial marketplace. A potential market for the aqueous HF has been identified as the current aqueous HF acid producers. The impact of HF sales on the local economy in which the existing producers are located and on the U.S. economy as a whole is likely to be minimal. No market for the CaF_2 that might be produced in the conversion facility has been identified. Should such a market be found, the impact of CaF_2 sales on the U.S. economy is also predicted to be minimal.

2.4.2.15 Impacts from D&D Activities

D&D would involve the disassembly and removal of all radioactive and hazardous components, equipment, and structures. For the purposes of analysis in this EIS, it was also assumed that the various buildings would be dismantled and "greenfield" (unrestricted use) conditions would be achieved. D&D impacts to involved workers would be primarily from external radiation; expected exposures would be a small fraction of operational doses; no LCFs would be expected. It is estimated that no fatalities and up to 5 injuries would result from occupational accidents. Impacts from waste management would include a total generation of about 275 yd^3 (210 m^3) of LLW, 157 yd^3 (120 m^3) of LLMW, and 157 yd^3 (120 m^3) of hazardous waste; these volumes would result in low impacts compared with projected site annual generation volumes.

2.4.2.16 Cumulative Impacts

The CEQ guidelines for implementing NEPA define cumulative effects as the impacts on the environment resulting from the incremental impact of an action under consideration when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7) Activities considered for cumulative analysis include those in the vicinity of the site.

Actions planned at the Paducah site include the continuation of uranium enrichment operations, waste management activities, waste disposal activities, environmental restoration activities, and DUF_6 management activities considered in this EIS.

In addition, the Paducah site is an alternative location for an advanced uranium enrichment facility. Actions occurring near the Paducah site that, because of their diffuse nature, could contribute to existing or future impacts on the site include continued operation of the Tennessee Valley Authority's (TVA's) Shawnee power plant; the Joppa, Illinois, power plant; and the Honeywell International uranium conversion plant in Metropolis, Illinois. Cumulative impacts of these actions at Paducah would be as follows for the no action alternative and the proposed action alternatives:

- The cumulative collective radiological exposure to the off-site population would be well below the maximum DOE dose limit of 100 mrem per year to the off-site maximally exposed individual (MEI). Annual individual doses to involved workers would be monitored to maintain exposure below the regulatory limit of 5 rem per year.

- Under the no action alternative cumulative impacts assessment, although less than one shipment per year of radioactive wastes is expected from cylinder management activities, up to 14,400 truck shipments could be associated with existing and planned actions (no rail shipments are expected). Under the action alternatives, up to 6,000 rail shipments and 18,600 truck shipments of radioactive material could occur. The cumulative maximum dose to the MEI along the transportation route near the site entrance would be less than 1 mrem per year under all alternatives and for all transportation modes.

- The Paducah site is located in an attainment region. However, the background annual average $PM_{2.5}$ concentration is near the regulatory standard. Cumulative impacts would not affect attainment status.

- Data from the 2000 annual groundwater monitoring showed that four pollutants exceeded primary drinking water regulation levels in groundwater at the Paducah site. Good engineering and construction practices should ensure that indirect cumulative impacts on groundwater associated with the conversion facility would be minimal.

- Cumulative ecological impacts on habitats and biotic communities, including wetlands, would be negligible to minor for all alternatives. Construction of a conversion facility might remove a type of tree preferred by the Indiana bat; however, this federal- and state-listed endangered species is not known to utilize these areas.

- No cumulative land use impacts are anticipated for any of the alternatives.

- It is unlikely that any noteworthy cumulative impacts on cultural resources would occur under any alternative, and any such impacts would be adequately mitigated before activities for the chosen action would start.

- Given the absence of high and adverse cumulative impacts for any impact area considered in this EIS, no environmental justice cumulative impacts are anticipated for the Paducah site, despite the presence of disproportionately high percentages of minority and low-income populations in the vicinity.

- Socioeconomic impacts under all alternatives considered are anticipated to be generally positive, often temporary, and relatively small.

2.5 PREFERRED ALTERNATIVE

DOE's preferred alternative is to construct and operate the proposed DUF_6 conversion facility at alternative Location A, which is located south of the administration building and its parking lot and east of the main Paducah GDP site access road.